

Real World Emissions and CO₂: Impacts of new US and EU testing

*John German
JG Automotive Consulting LLC*

April 17, 2019
Automotive Research Conferences
Real World Driving: Government Regulations, OEM
Response, and Impacts on Customers
Ann Arbor, Michigan

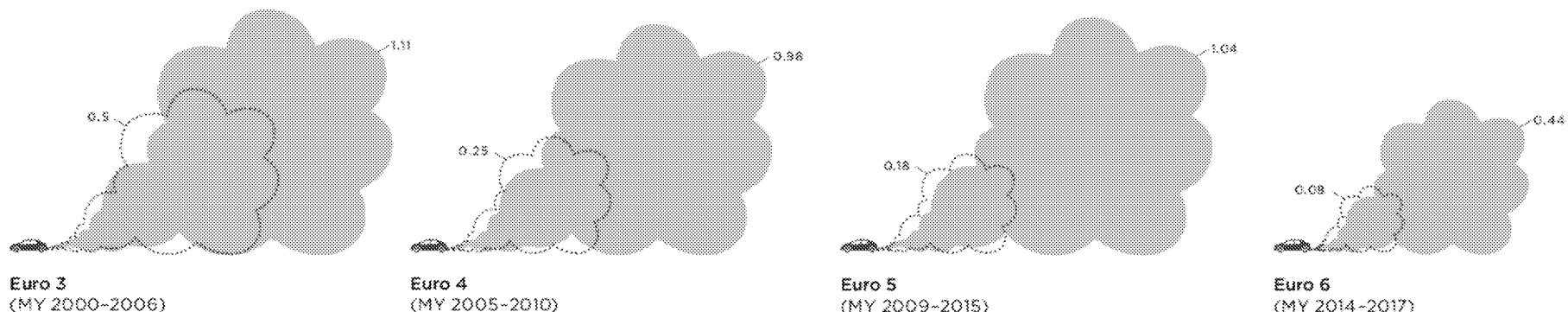


**air pollutant
emissions**

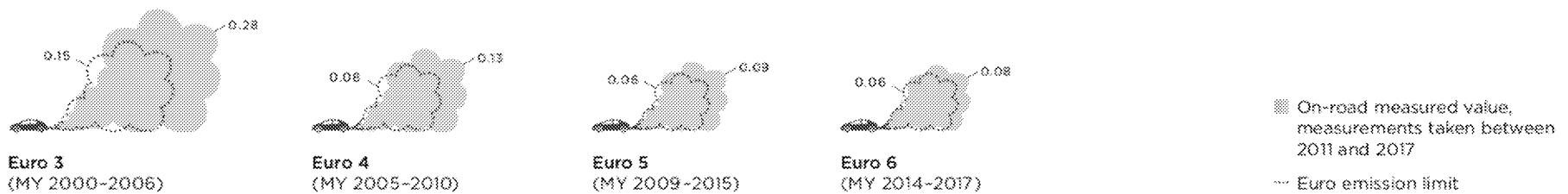
**CO₂ and
fuel consumption**

In reality, nitrogen oxides emissions from diesel cars in Europe have not decreased as expected

Diesel cars: Nitrogen oxide (NO_x) emissions (in g/km)

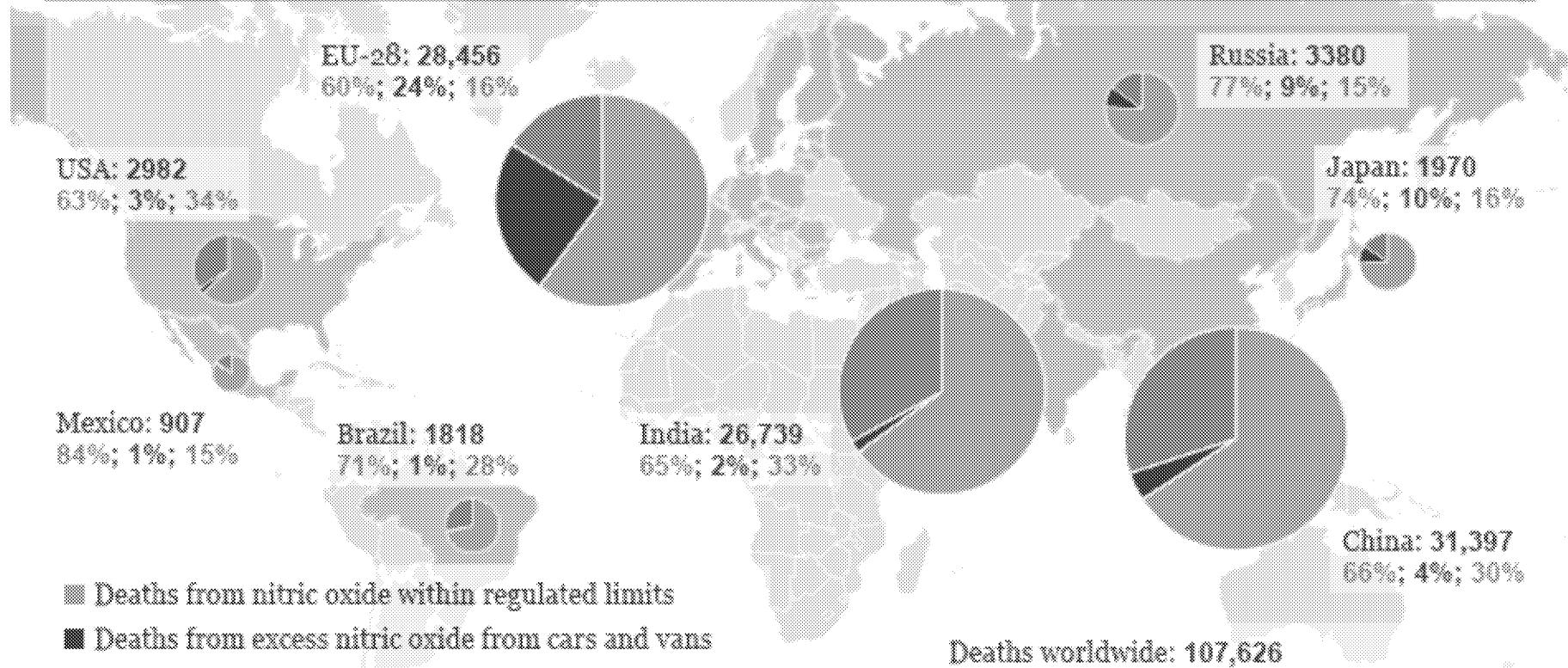


Gasoline cars: Nitrogen oxide (NO_x) emissions (in g/km)



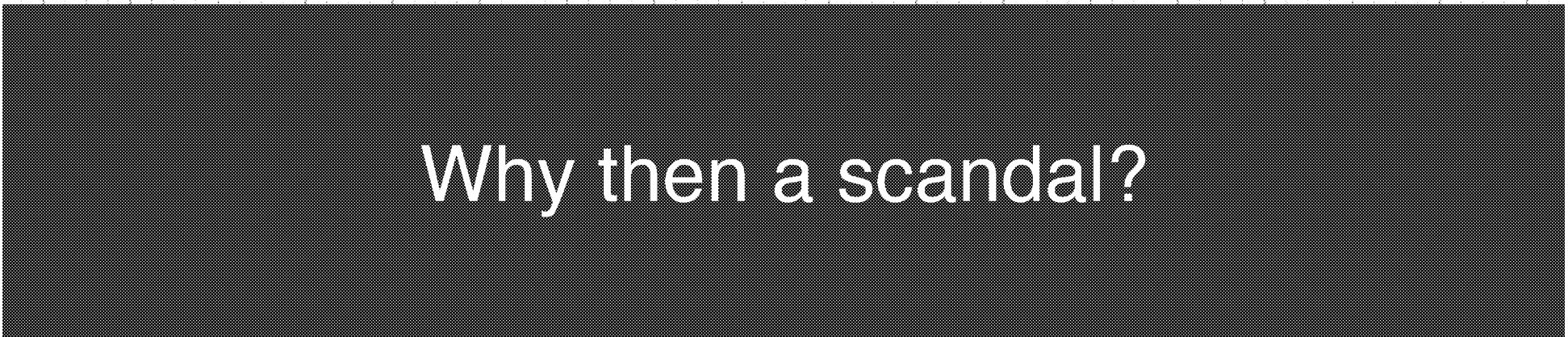
In Europe, more than 11,000 people die early because of excess diesel NO_x emissions, every year

Deaths caused by nitric oxide from diesel engines worldwide in 2015



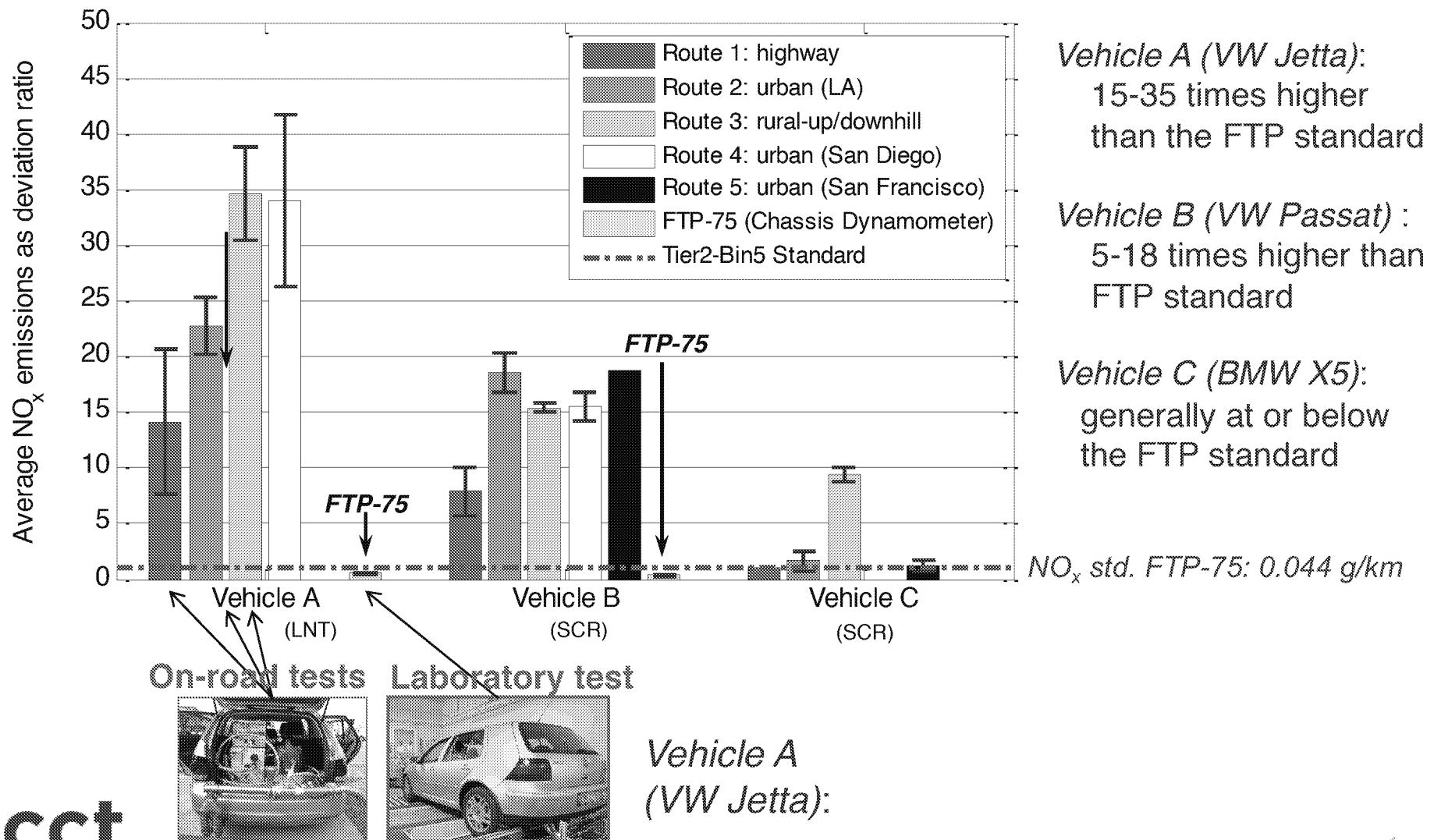
Source: International Council on Clean Transportation | May 15, 2017

© DW

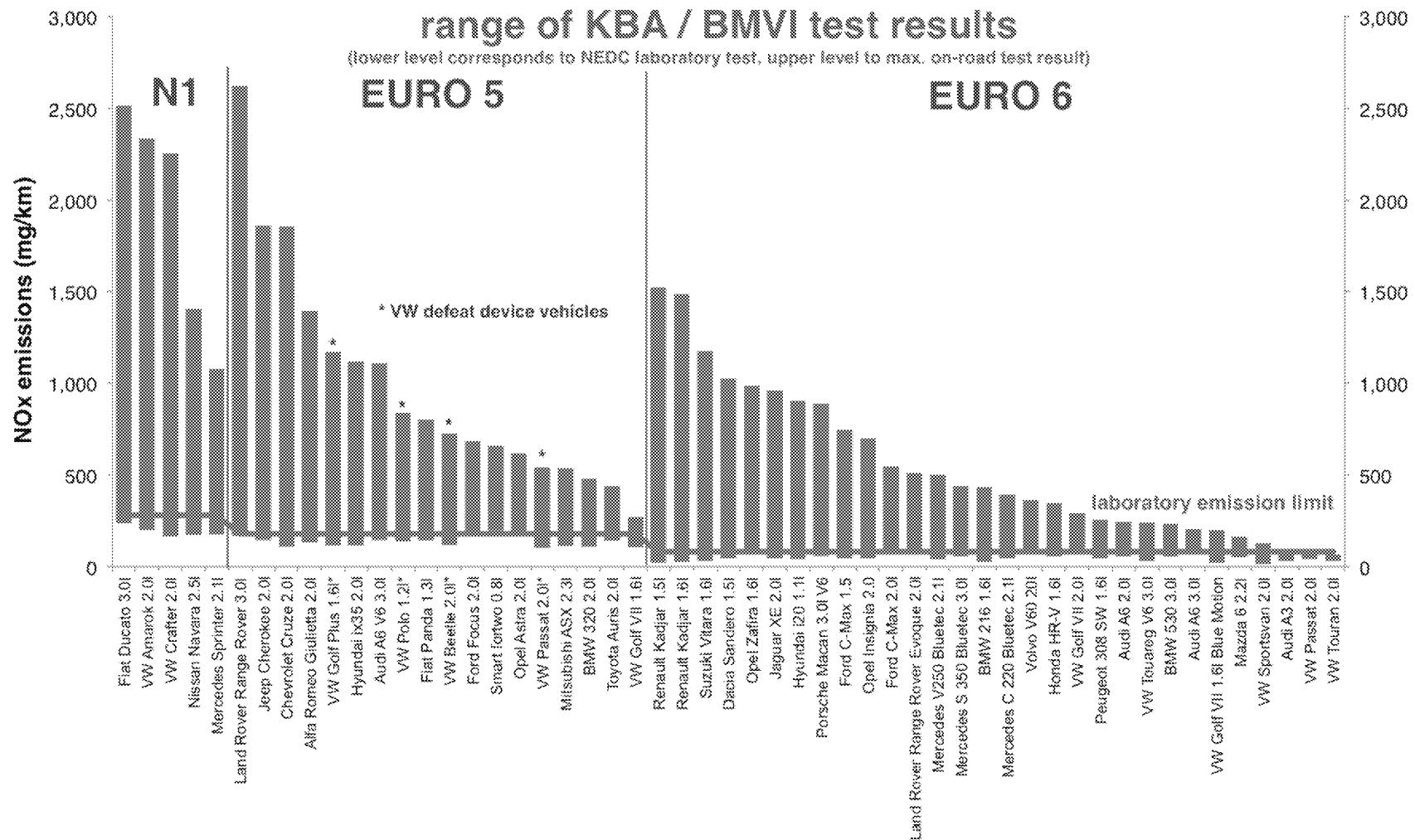


Why then a scandal?

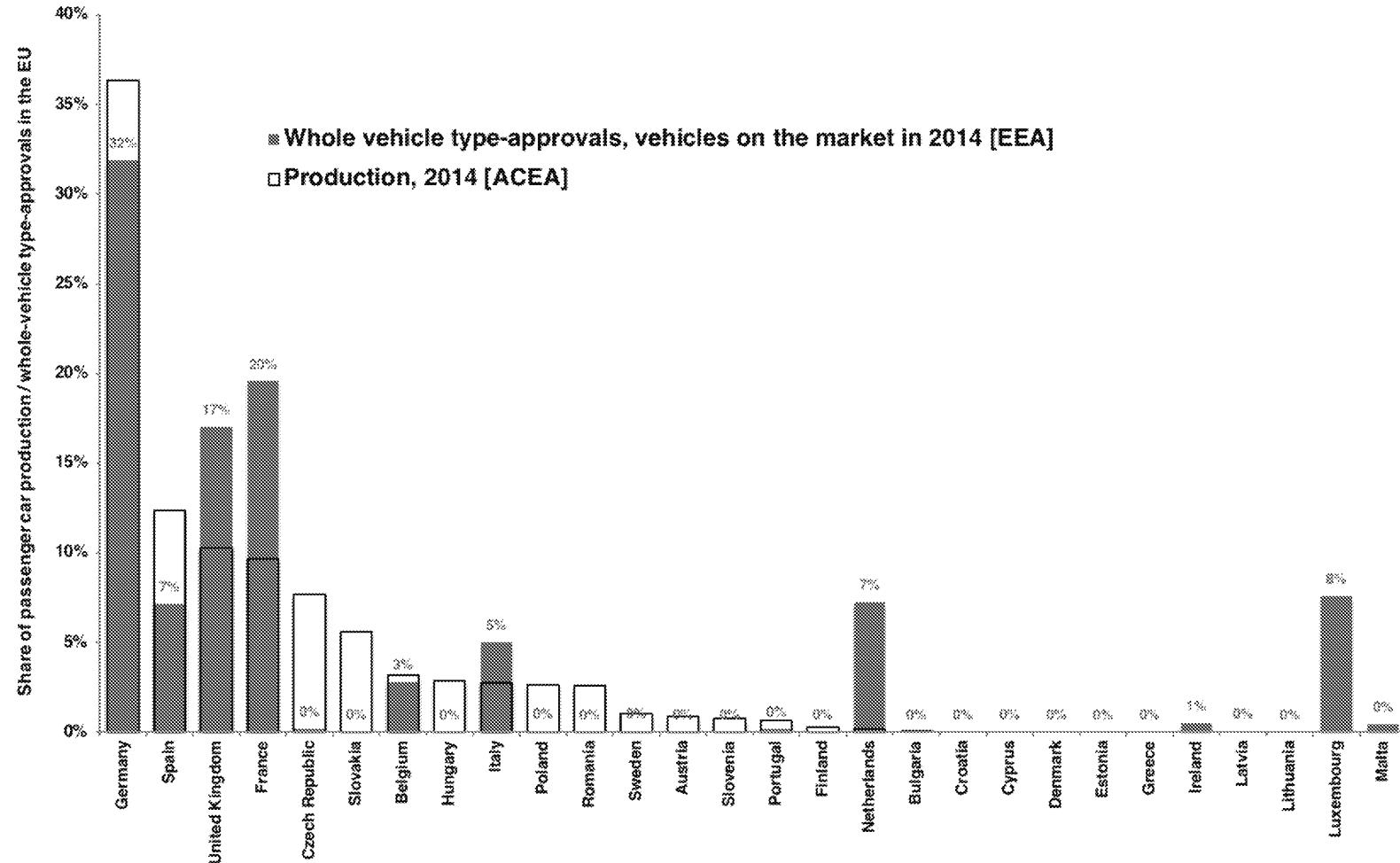
US PEMS Route NO_x emissions and CARB chassis results



EU government testing has confirmed earlier findings and points to numerous other defeat devices



A manufacturer can easily outsource its emissions' testing to one of the EU's 'type-approval heavens'



'Engine protection' turned out to be a useful excuse for nearly all the defeat devices currently in use

Article 5

Requirements and tests

1. The manufacturer shall equip vehicles so that the components likely to affect emissions are designed, constructed and assembled so as to enable the vehicle, in normal use, to comply with this Regulation and its implementing measures.

2. The use of defeat devices that reduce the effectiveness of emission control systems shall be prohibited. The prohibition shall not apply where:
 - (a) the need for the device is justified in terms of protecting the engine against damage or accident and for safe operation of the vehicle;

 - (b) the device does not function beyond the requirements of engine starting;
or
(c) the conditions are substantially included in the test procedures for verifying evaporative emissions and average tailpipe emissions.

The list of discovered defeat devices is long and is rapidly becoming longer

- Speed profile of the vehicle
- Steering wheel position
- Timer
- “Thermo-window”
- Maximum speed
- Altitude
- Engine speed
- Inclination
- ...
- New Euro 6 defeat device
- ...
- Combination of several defeat devices

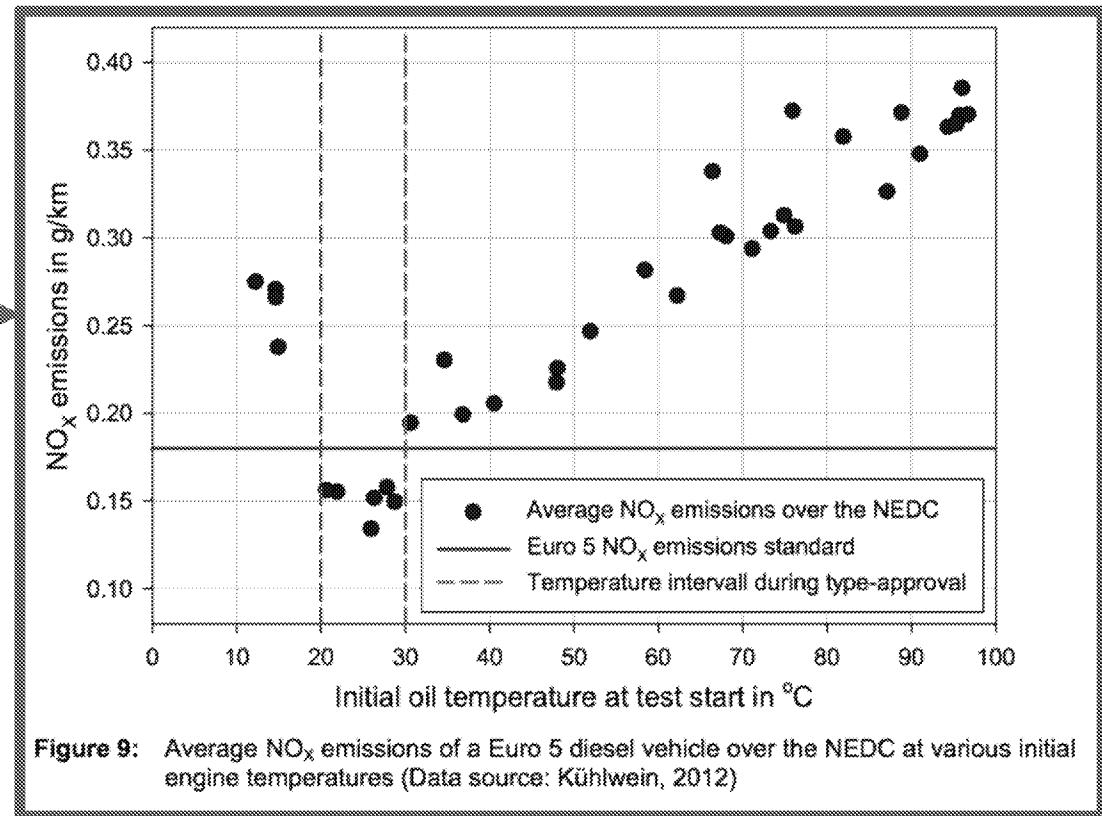
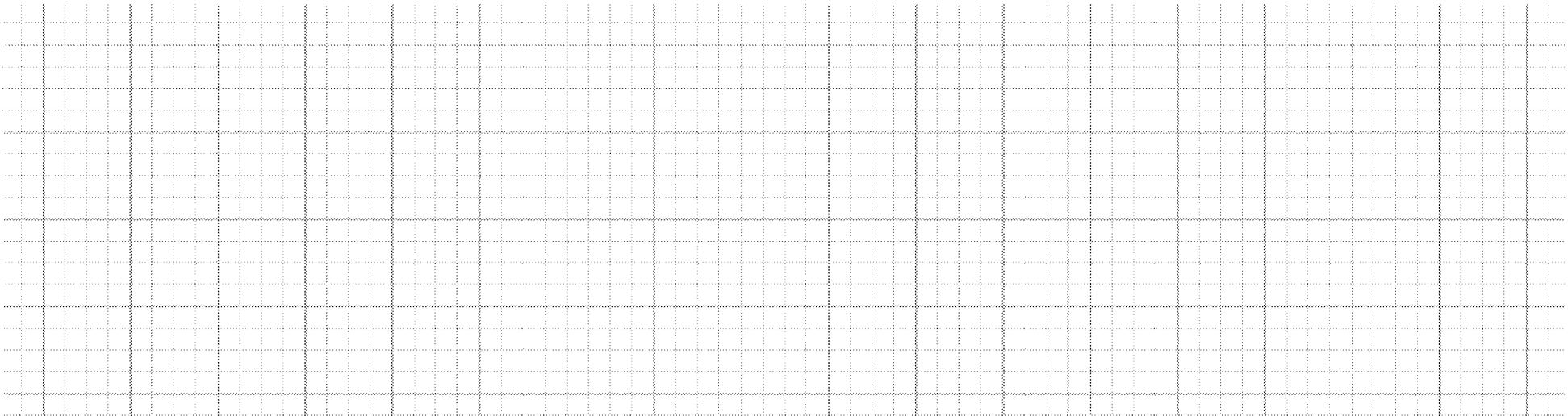


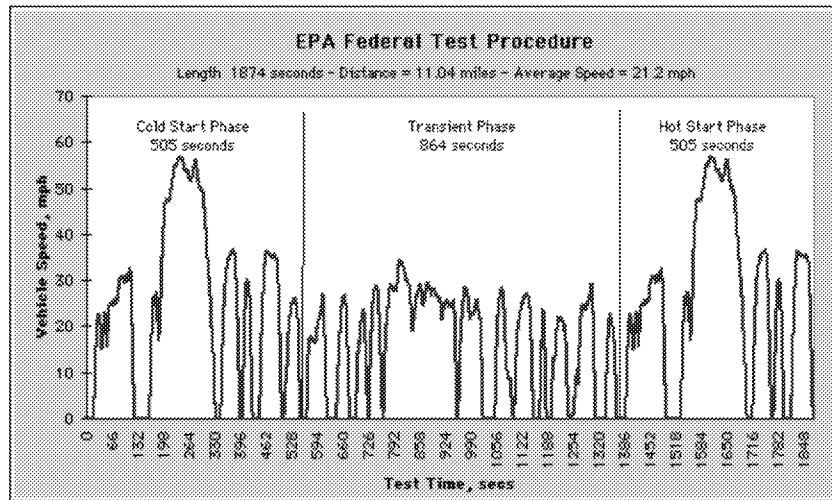
Figure 9: Average NO_x emissions of a Euro 5 diesel vehicle over the NEDC at various initial engine temperatures (Data source: Kühlwein, 2012)

Source: http://publications.jrc.ec.europa.eu/repository/bitstream/JRC75998/ld-na-25572-en-n_online.pdf

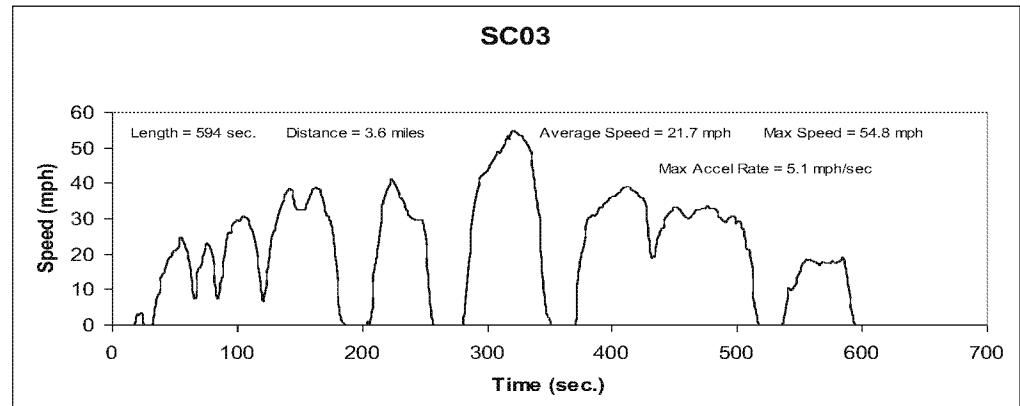


The response

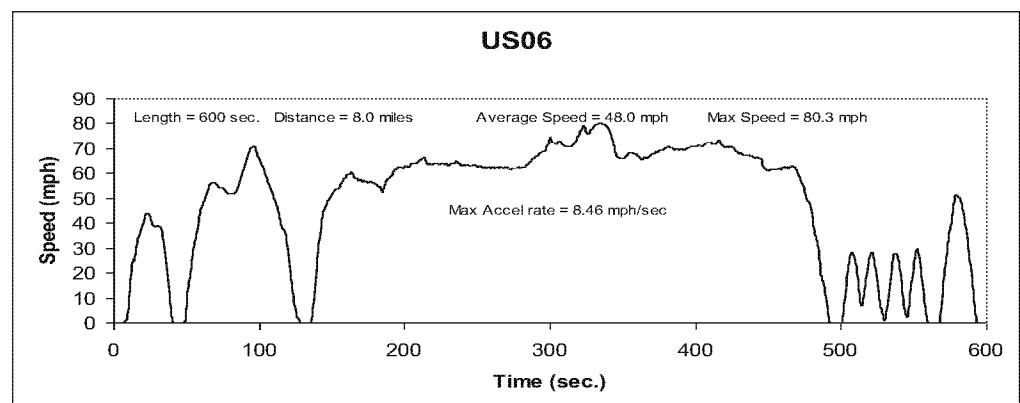
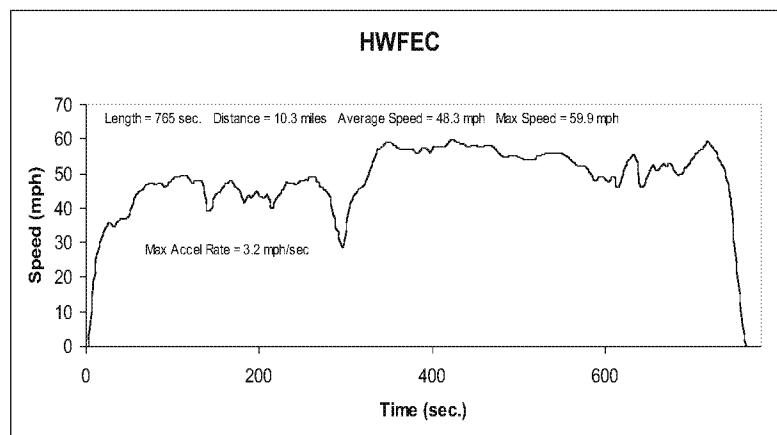
US: Wide variety of existing test cycles



Cold starts at 75°F and 20°F with hot restarts



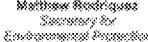
Designed to account for effects of air conditioning under hot ambient conditions (95°F, full sun load)



Aggressive driving – high speeds and acceleration

The US authorities fined VW and immediately introduced new in-use vehicle testing methods

 **Air Resources Board**
Mary D. Nichols, Chair
9490 Teister Avenue, Suite 4
El Monte, California 91731 • www.arb.ca.gov

 Matthew Rodriguez
Secretary for
Environmental Protection

 Edmund G. Brown Jr.
Governor

Reference No. IUC-2015-008

September 26, 2016

Dear Manufacturer:

Under California Code of Regulations, title 13, sections 1966.1, 1966.8, 1961, 1961.1, 1961.2, and 1961.3, on new passenger car, light-duty truck, medium-duty passenger vehicle, medium-duty vehicle, or complete heavy-duty vehicle shall be equipped with a defeat device. Under these regulations, a defeat device is defined (as incorporated by reference) as "an auxiliary emission control device (AECD) that reduces the effectiveness of the emission control system under conditions which may reasonably be expected to be encountered in normal vehicle operation and use, unless" certain conditions are met. If used, AECD's must be disclosed and approved at the time of certification. Failure to disclose or properly identify an AECD or employing a defeat device will invalidate any applicable Executive Order, and is a violation of California law, including but not limited to Health and Safety Code Sections 43150-43154, and 43016.

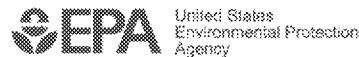
Beginning immediately, the Air Resources Board (ARB) will begin to utilize recently developed screening tests, which are based on ARB's original work for assessing performance of modern light duty diesel vehicles, in ARB's In-Use Compliance Program for non-approved AECD and defeat device identification. The AECD and defeat device screening tests will be based on ARB's newly-developed detection methods , and may include onboard diagnostic system interrogation, and/or the use of over-the-road testing using a Portable Emission Measurement System, and/or the use of special driving cycles and conditions that may reasonably be expected to be encountered in normal operation and use. This new screening testing approach shall be in addition to the standard certification emissions test cycles.

In the event that a suspected, non-approved AECD or defeat device is discovered through use of the screening tests, the manufacturer will be notified, and will be expected to deliver production, or procure in-use, vehicles for additional in-use compliance evaluation by ARB at the manufacturer's expense, pursuant to California Code of Regulations, title 13, section 2111-2140. In addition, ARB may require remedial measures to be taken at the manufacturer's expense, and the manufacturer may be

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, see our website: www.energycff.ca.gov.

California Environmental Protection Agency
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The US authorities are still investigating other manufacturers, potential penalties to follow

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Bosch reaches \$328m settlement in VW emissions scandal

Company made component used by carmaker to enable vehicles to cheat emissions tests

© FT montage / EPAPatrick McGee in Frankfurt FEBRUARY 1, 2017

Fiat Chrysler Automobiles Air Act Civil Settlement Information Sheet

(Washington, DC – January 10, 2019) – The Department of Justice, the Environ

BUSINESS NEWS APRIL 26, 2017 / 8:27 AM / A YEAR AGO

Daimler says diesel probes could result in penalties, recalls

Reuters Staff8 MIN READ

FRANKFURT (Reuters) - Daimler on Wednesday reiterated that recent steps by United States authorities to investigate diesel emissions pollution and so-called auxiliary emission control devices could lead to significant penalties and vehicle recalls.

Bosch has agreed to pay \$327.5m to resolve allegations in the US that it played a significant role in Volkswagen's diesel emissions scandal.

For Fiat, the German government insists there is an illegal defeat device in use, but Italy does not act

 Bundesministerium
für Verkehr und
Digitale Infrastruktur

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Ministero delle Infrastrutture e dei Trasporti
DIPARTIMENTO PER I TRASPORTI LA NAVIGAZIONE
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Bereits Unregelmäßigkeiten in der Abgasnachbehandlung an
Fahrzeugen des Herstellers „Fiat-Chrysler-Automobile“ (FCA)
- Maßnahmen gemäß Artikel 36 der Richtlinie 2007/46/EG -

Datum: Bonn, 31.08.2016
Seite 1 von 2

Sehr geehrter Herr Kollege Vitelli,

aufgrund von Hinweisen zu Unregelmäßigkeiten im Benzinabgasnachbehandlungssystem bei Euro 6-Fahrzeugen mit Dieselmotoren (Fiktionszettel 1.6, 2.0) und 2.2) des Herstellers Fiat-Chrysler im Rahmen der Überprüfungen der Untersuchungskommission VW¹, hat das KBA eigene Untersuchungen an weiteren vier FCA-Fahrzeugen durchgeführt. Die Ergebnisse dieser Untersuchungen zeigen deutlich, dass bei allen überprüften Fahrzeugen ein qualitativ ähnliches Verhalten im Anstieg von NO_x-Emissionen, von Zylinder zu Zyklus vorliegt. Mit der Abschaltung der Regeneration des NO_x-Speicher-Katalysators (NSK) nach sechs Regenerationszyklen steigen die NO_x-Werte stark auf das 2- bis 15-Fache des Grenzwerts. Daraus geht die Abschaltung der Abgasrückführung (AGR) nach 22 Minuten sowie die Einstellung der Regeneration des NSK nach ca. sechs Regenerationszyklen. Demnach ist aus unserer Sicht der Nachweis des Einsatzes einer unzulässigen Abschaltseinrichtung erbracht.

Ergänzend haben Sie eigene Tests vorgenommen (NETZ hat auf dem Testfahrprofil sowie einer PEMS-Prüfung (NETZ) zur Verifikation der Reihenergebnisse) und kommen zu dem Ergebnis, dass das Vorhandensein einer Abschaltseinrichtung ausgeschlossen sei.

¹ Schreiben BMF Alexander Dobrindt an Frau Kommissarin Blaakemeyer und Frau Kommissarin Rabe aus dem Mai 2017



German government orders mandatory recalls for Euro 6 vehicles, but still no penalties

DER TAGESSPIEGEL

Abgasskandal

06.06.2018 | 15:48 Uhr

Audi muss 60.000 Diesel-Autos zurückrufen

Viele Audi-Besitzer müssen handeln: Wegen einer "unzulässigen Abschalteinrichtung" bei der Abgasreinigung muss Audi tausende Wagen in die Werkstatt holen.



Streit um Abschalteinrichtung

Daimler muss europaweit 774.000 Diesel zurückrufen

Abgasuntersuchung eines Dieselmotors

Von dpa 11. Juni 2018 - 19:50 Uhr

Stuttgart/Berlin - Zwei Wochen war Zeit, nun liegen die Zahlen auf dem Tisch - und für Daimler-Chef Dieter Zetsche durften sie schwer zu verdauen sein. In 774.000 Autos von Mercedes-Benz soll eine unzulässige Abschalteinrichtung für die Abgasreinigung stecken.

Und Verkehrsminister Andreas Scheuer (CSU) will nun schnellstens Taten von Zetsche sehen. Die wichtige Frage, welche Ausmaße der Fall hat, ist beantwortet - aber es ist nicht die einzige. Denn einfach so hinnehmen will Daimler Scheuers Anweisung nicht.

SPIEGEL ONLINE SPIEGEL

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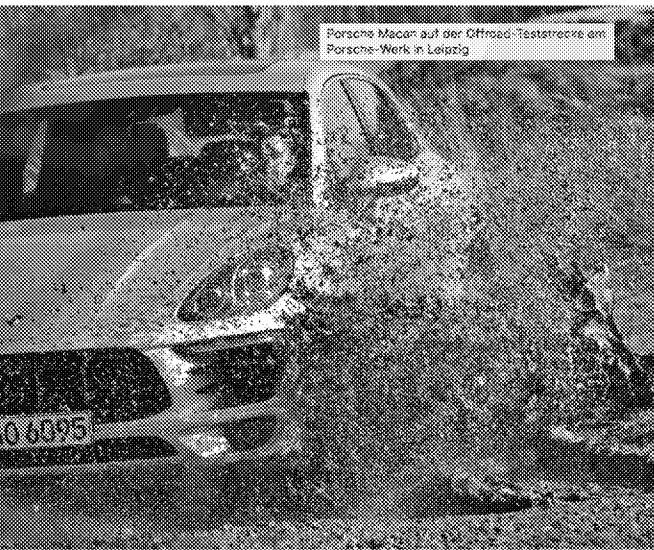
MOBILITÄT

Schlagzeilen | Wetter | SAX 12.817,48 | TV-Programm | Auto

Kommunikation > Mobilität > Automobil > Auto-Markt > Formeller Untersuchung und Maßnahmen Kraftfahrt-Bundesamt erhält erneut wichtigen Auftrag

Abgasskandal Kraftfahrt-Bundesamt ruft 60.000 Porsche zurück

Dreister Abgasbetrug bei zwei Porsche-Modellen: Behörden rufen die Luxusgeländewagen Cayenne und Macan zurück, weil sie gleich mehrere Software-Manipulationen entdeckt haben.

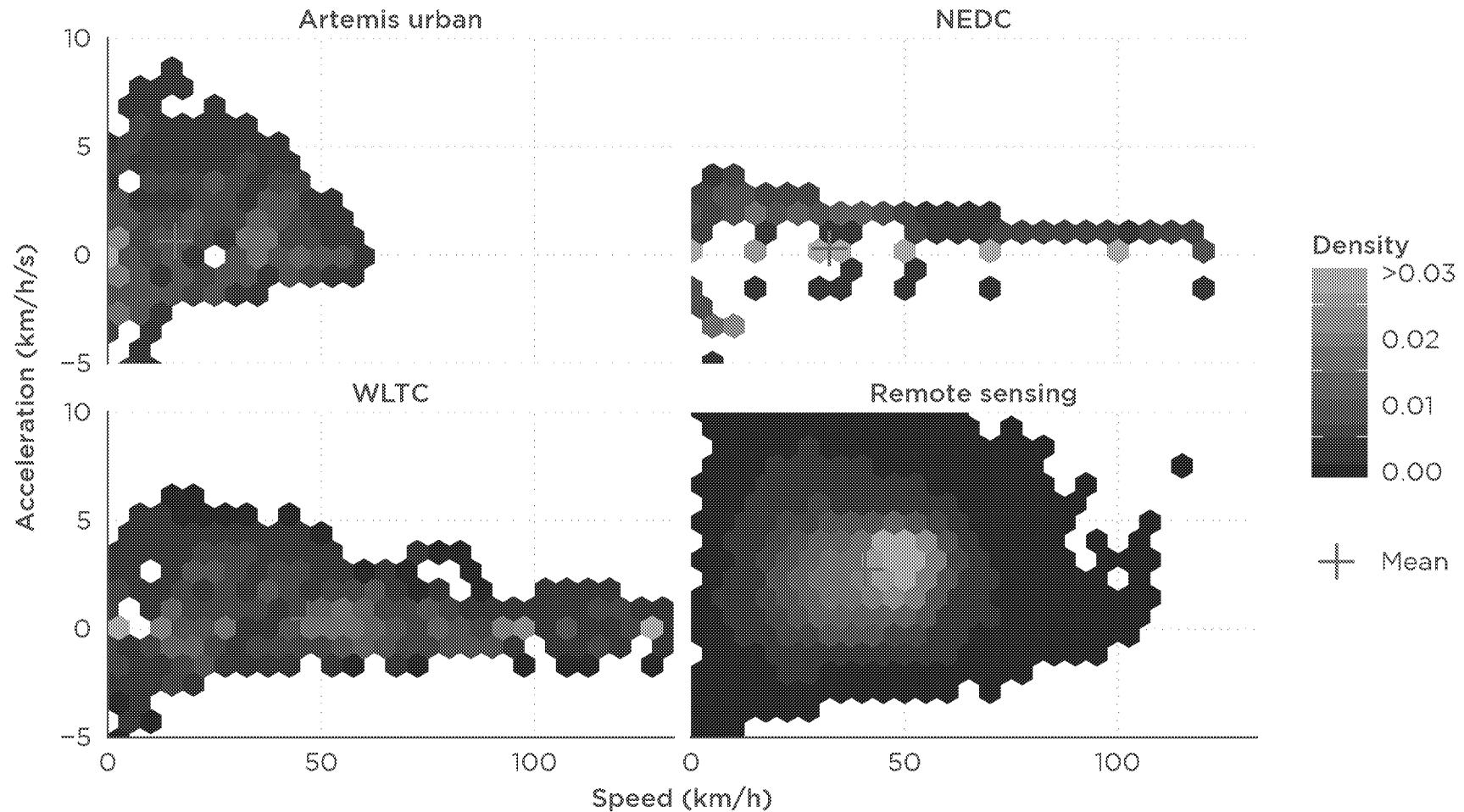


Porsche Macan auf der Offroad-Teststrecke am Porsche-Werk in Leipzig

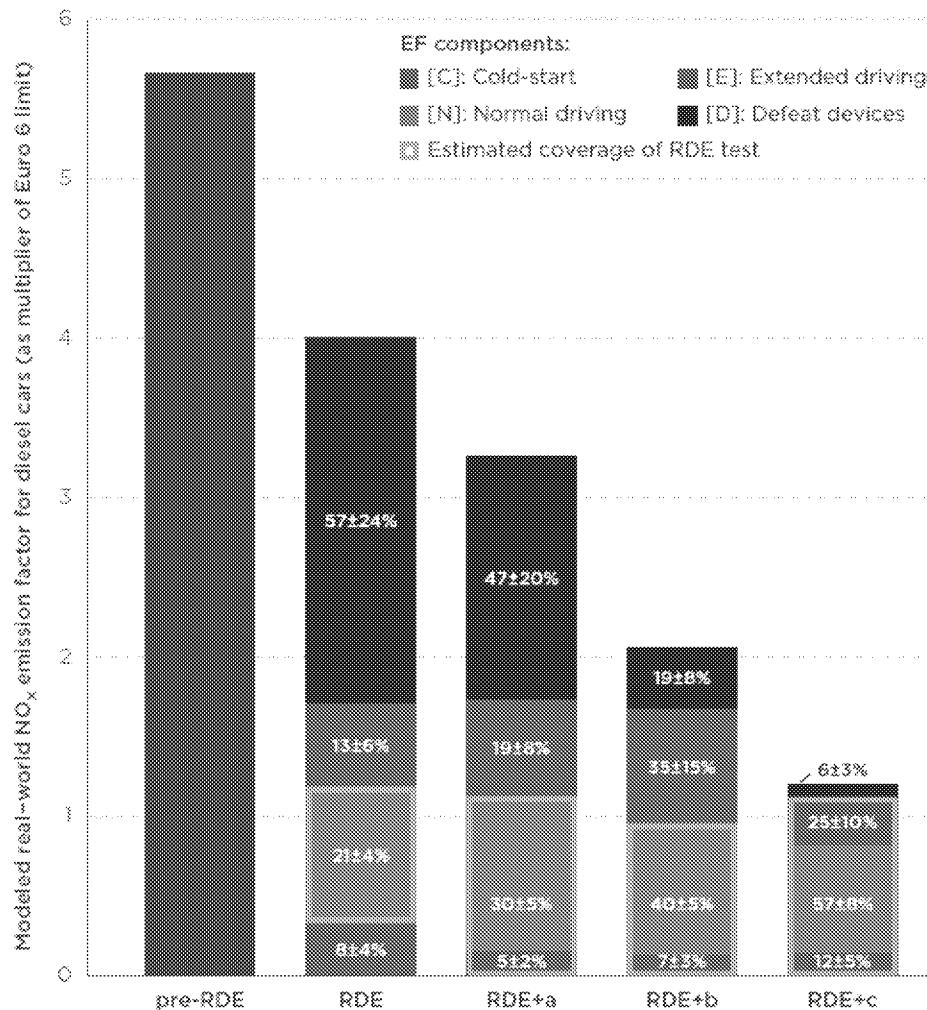
Angeklagte von Abgas-Vorwürfen gegen den Autobauer Daimler ist der Verhandlungsleitende Direktor Zeissig erneut ins Bundesverkehrsministerium gekommen. Foto: Kay Nietfeld

in Porsche-Werk in Leipzig

EU: New test procedures will help targeting “normal” driving conditions, but cannot detect all defeat devices



RDE will help targeting “normal” driving conditions and cold-start, but not all defeat devices



RDE potential loopholes:

- 1) Defined urban, rural, motorway sequence
- 2) Relatively mild speeds and accelerations; limited ambient temperatures
- 3) Package 4 adds in-use surveillance, but will it be enforced?

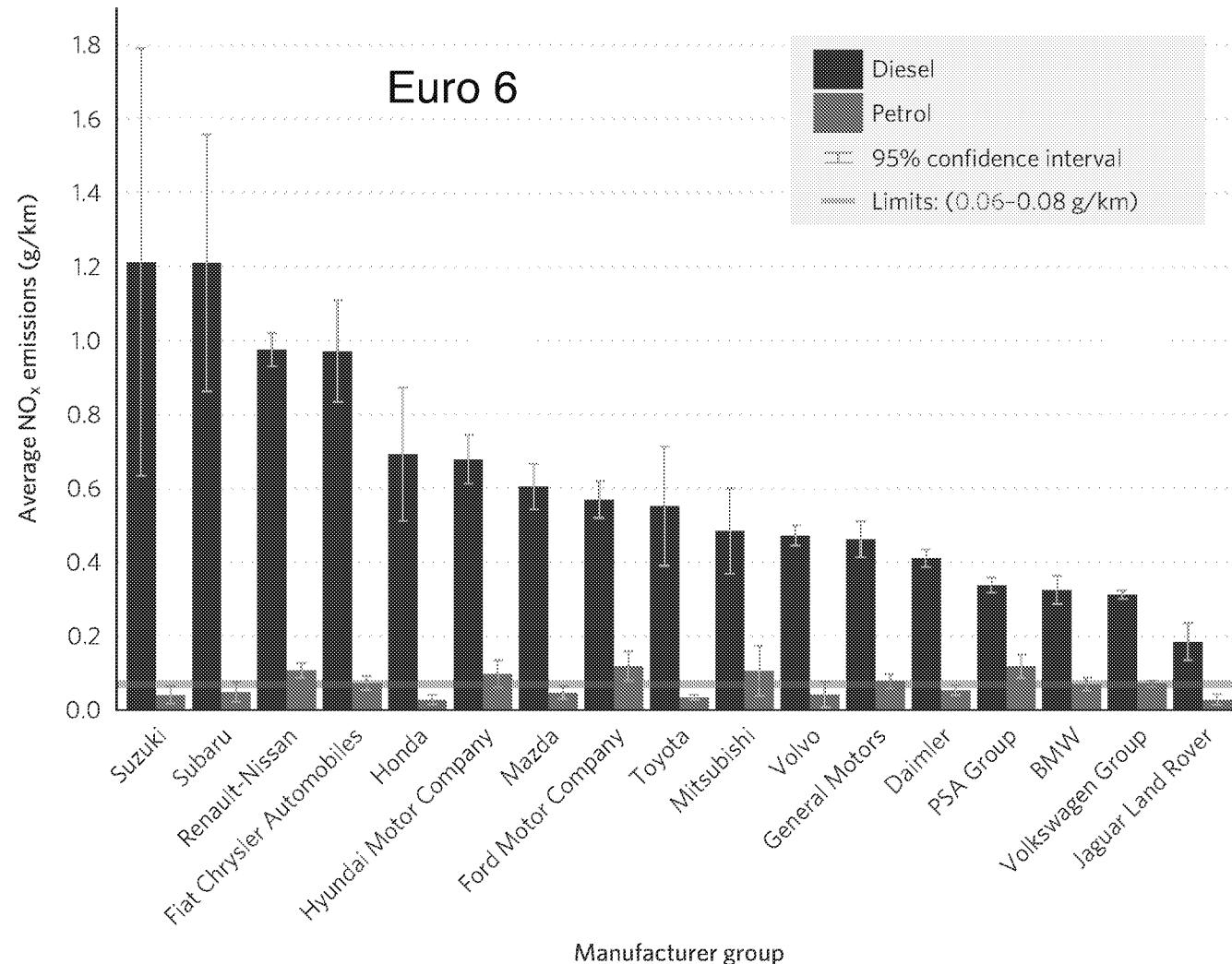
New EU Type-Approval Framework Legislation

While it largely maintains the basic architecture of the EU type-approval system:

- Environmental Commission may carry out its own verification testing and initiate vehicle recalls
- Introduces independent market surveillance
- Member states will be allowed to restrict or prohibit the usage of affected vehicles or require actions by the manufacturer, even if certified by a different member.

European Council, Council of the European Union, “Approval and market surveillance for cars,” March 2018.
Retrieved from <http://www.consilium.europa.eu/en/policies/type-approval-for-cars/>

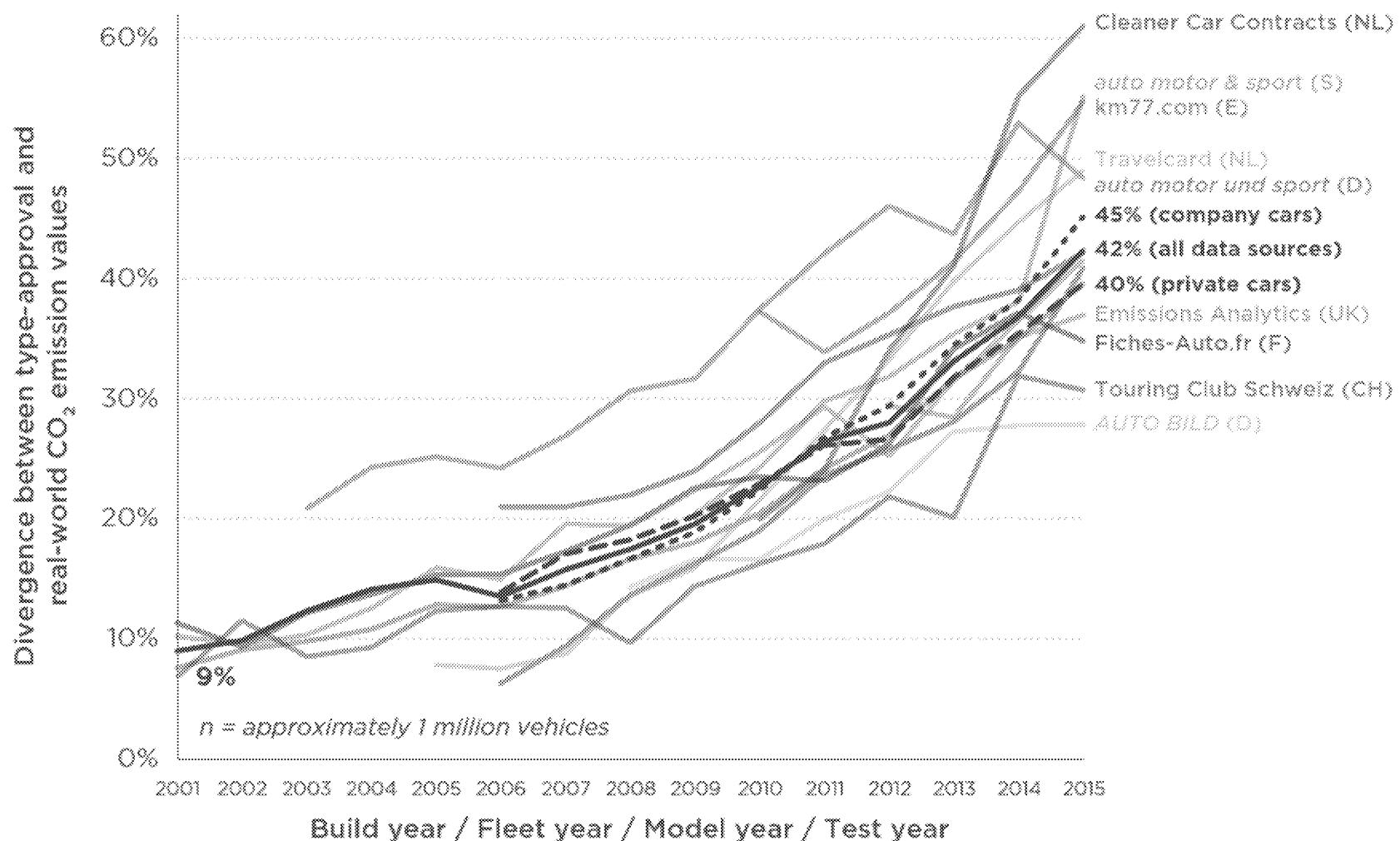
Remote sensing data allows drawing conclusions about the on-road performance of individual brands



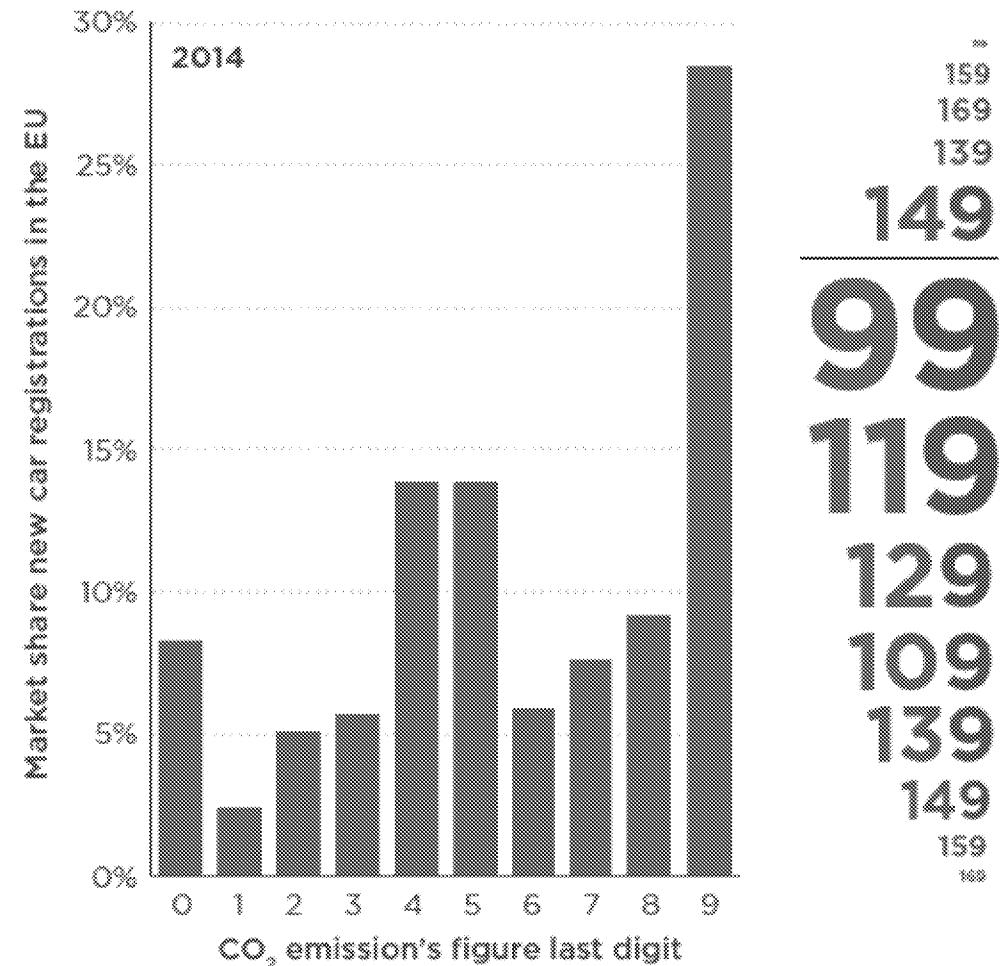
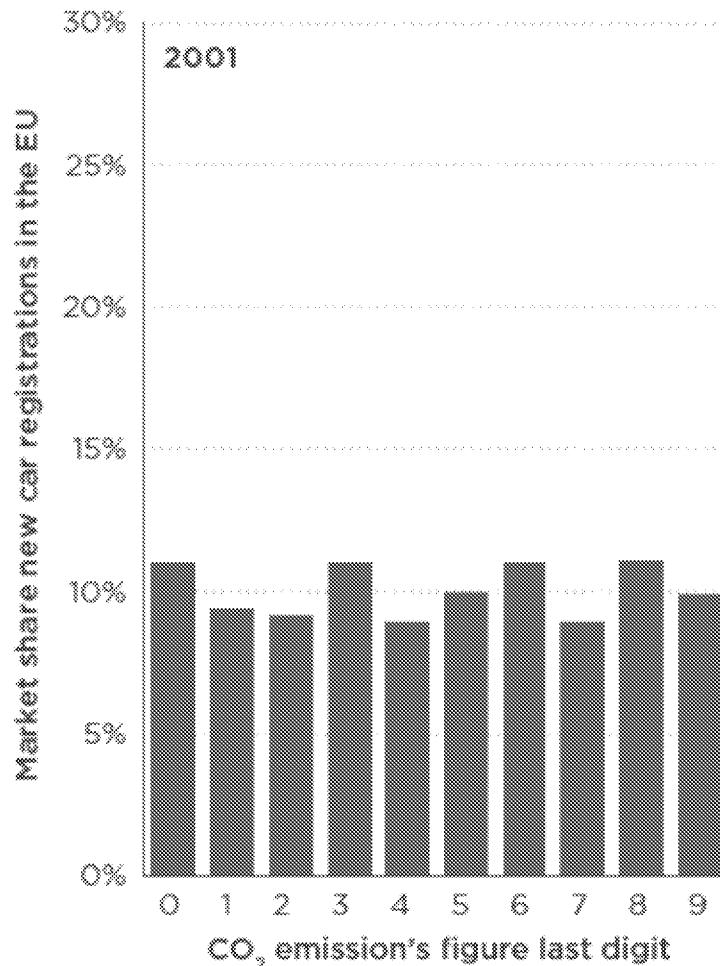
**air pollutant
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**CO₂ and
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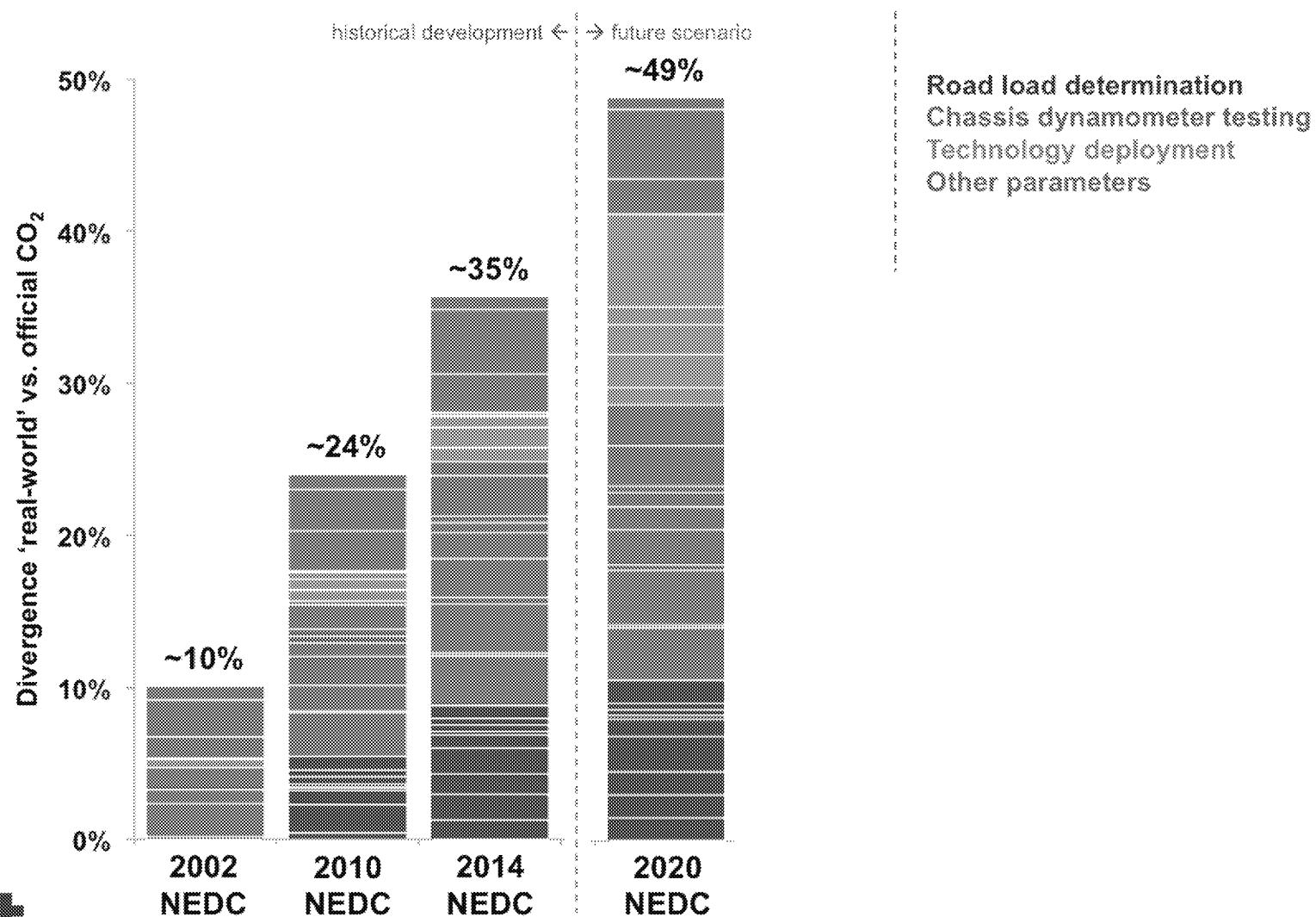
An average new car emits about 42% more of CO₂ than advertised by the manufacturer



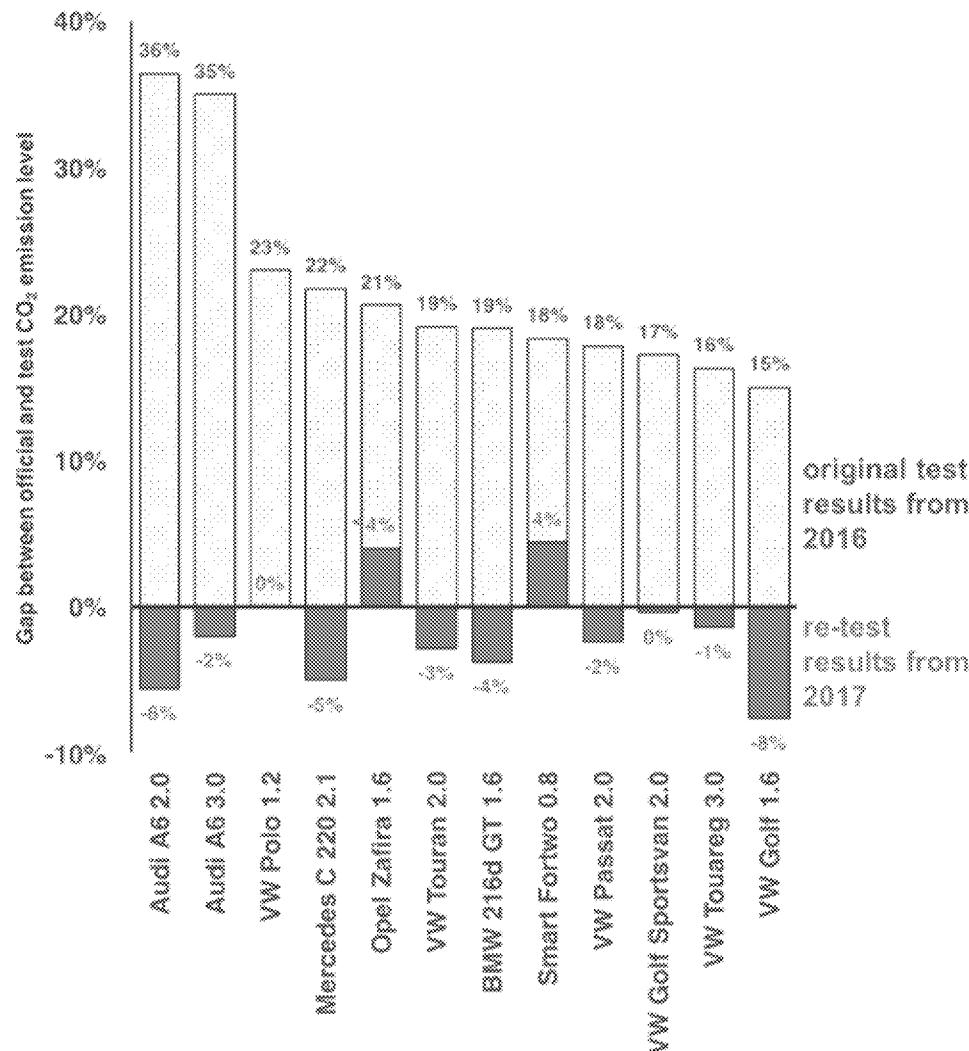
The new car CO₂ regulation and CO₂ based vehicle taxation have increased the incentive to ‘cheat’



There is a large number of loopholes in the test procedure that are being systematically exploited



For CO₂, BMVI re-tested vehicles using ‘testing advice’ from manufacturers



2016 tests conducted by Germany’s Ministry for Transport (BMVI) using type-approval laboratory tests

2017 tests were re-tested using “testing advice” from manufacturers, exploiting tolerances in vehicle procurement and testing



The response

The real-world CO₂ gap is a global issue

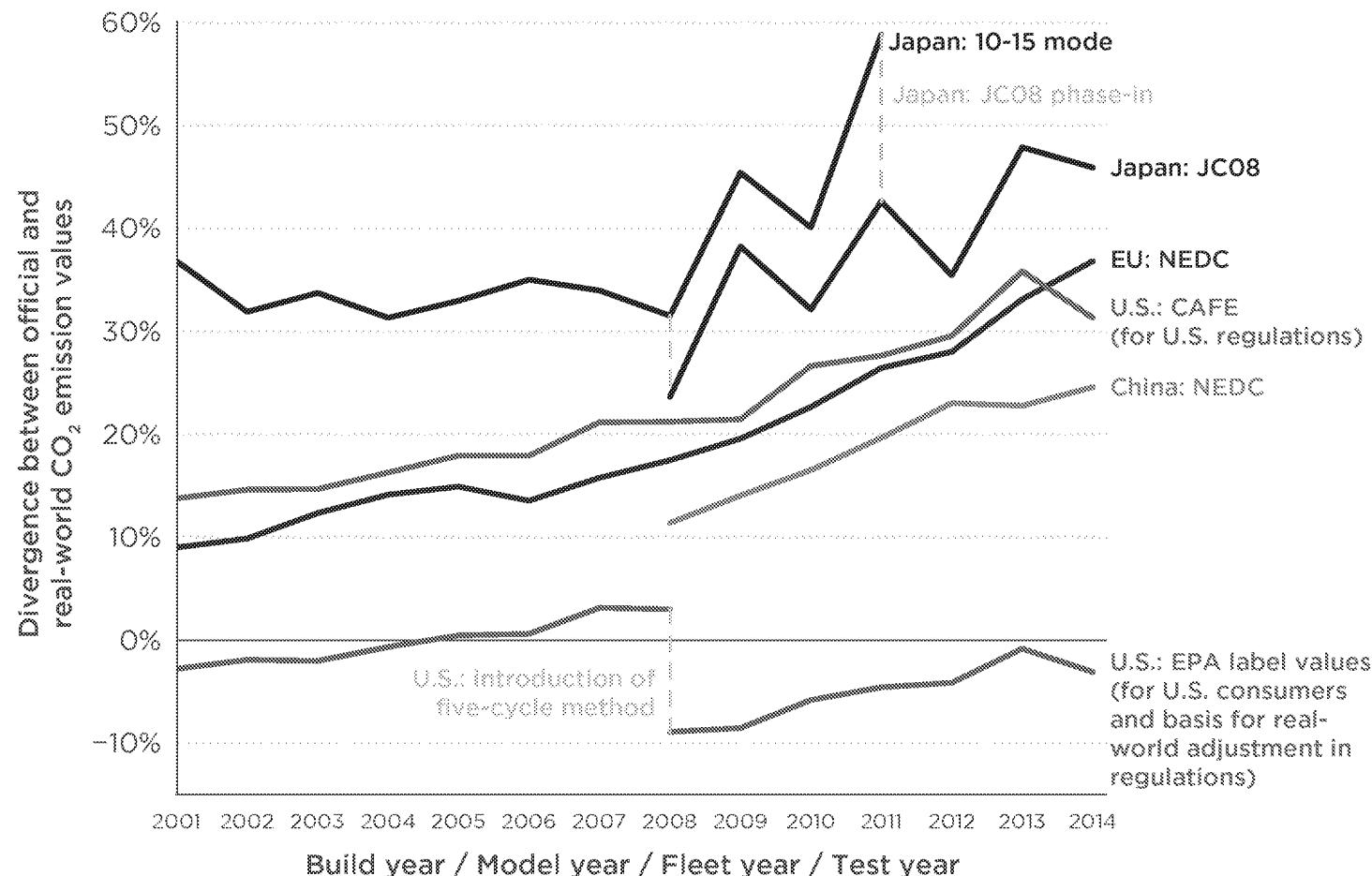
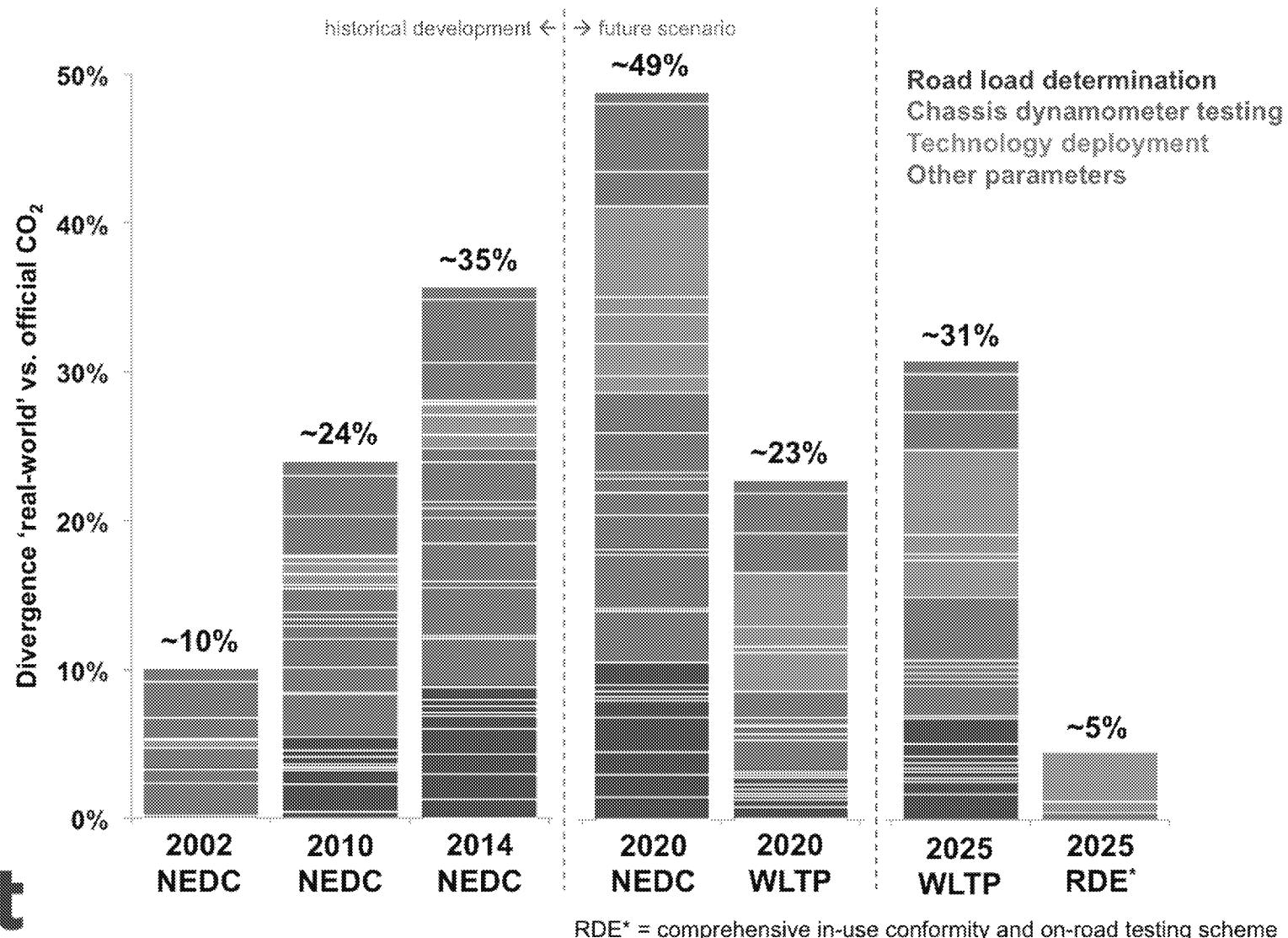


Figure 2. Divergence between real-world and manufacturers' type-approval CO₂ emission values for China, Europe, Japan, and the United States.

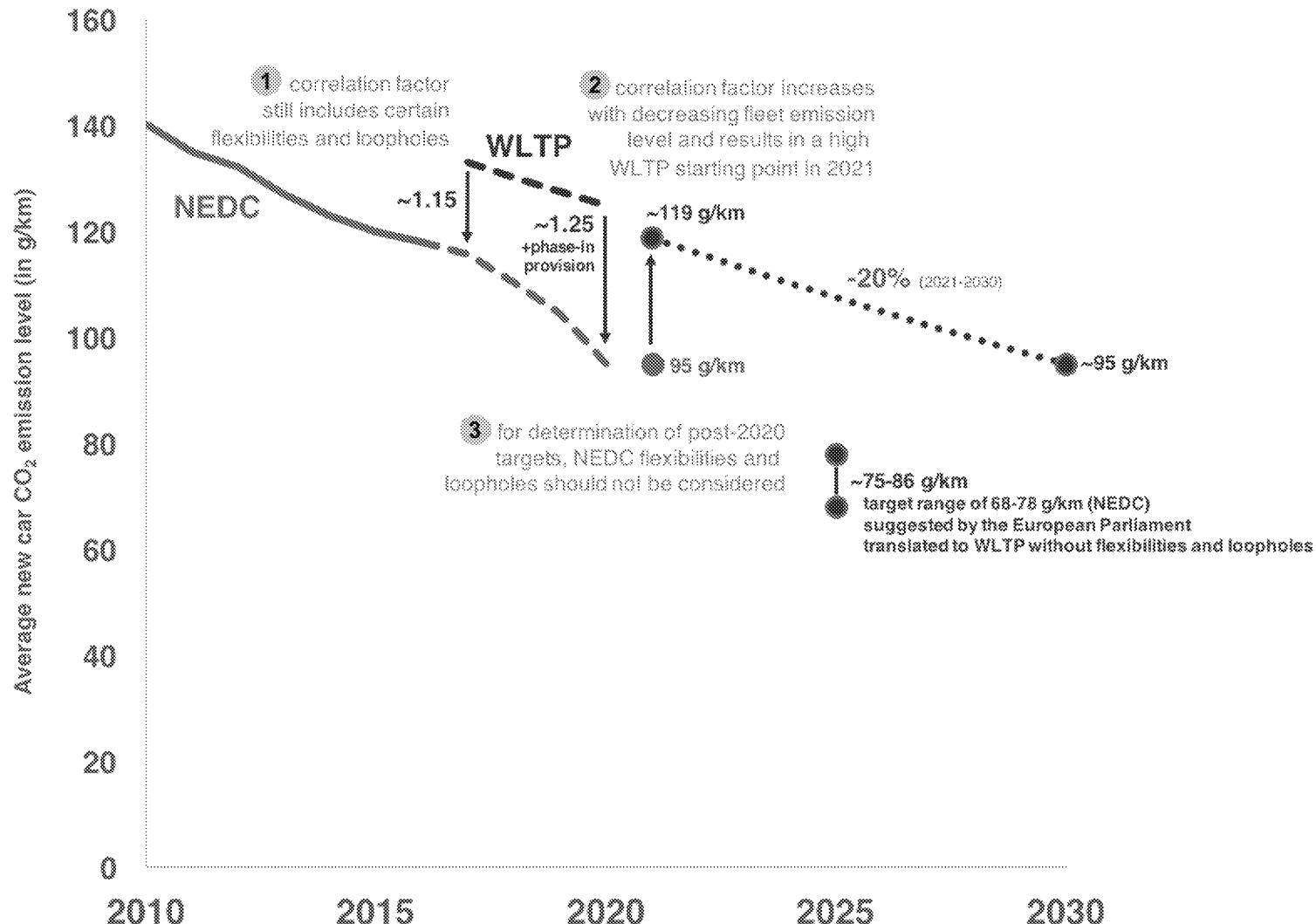
Data sources

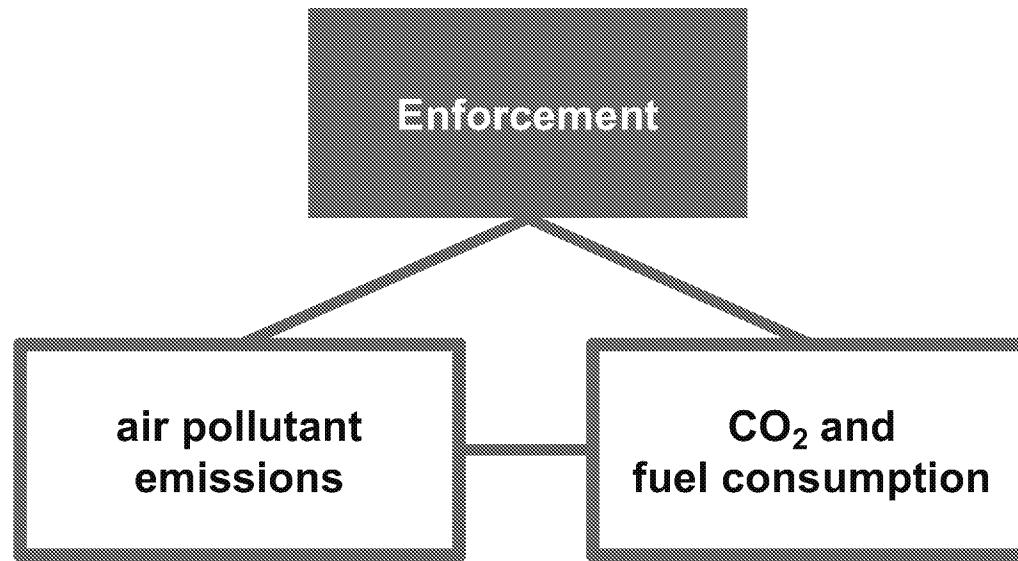
- www.e-epa.org
- www.theicct.org/laboratory-road-2015-update
- www.luckyeconomy.gov
- <http://www.icct.org.cn/english/admin/upload/2015071073476825.pdf>

Broadening the coverage of the testing procedure is one important pillar: NEDC → WLTP → RDE-CO₂

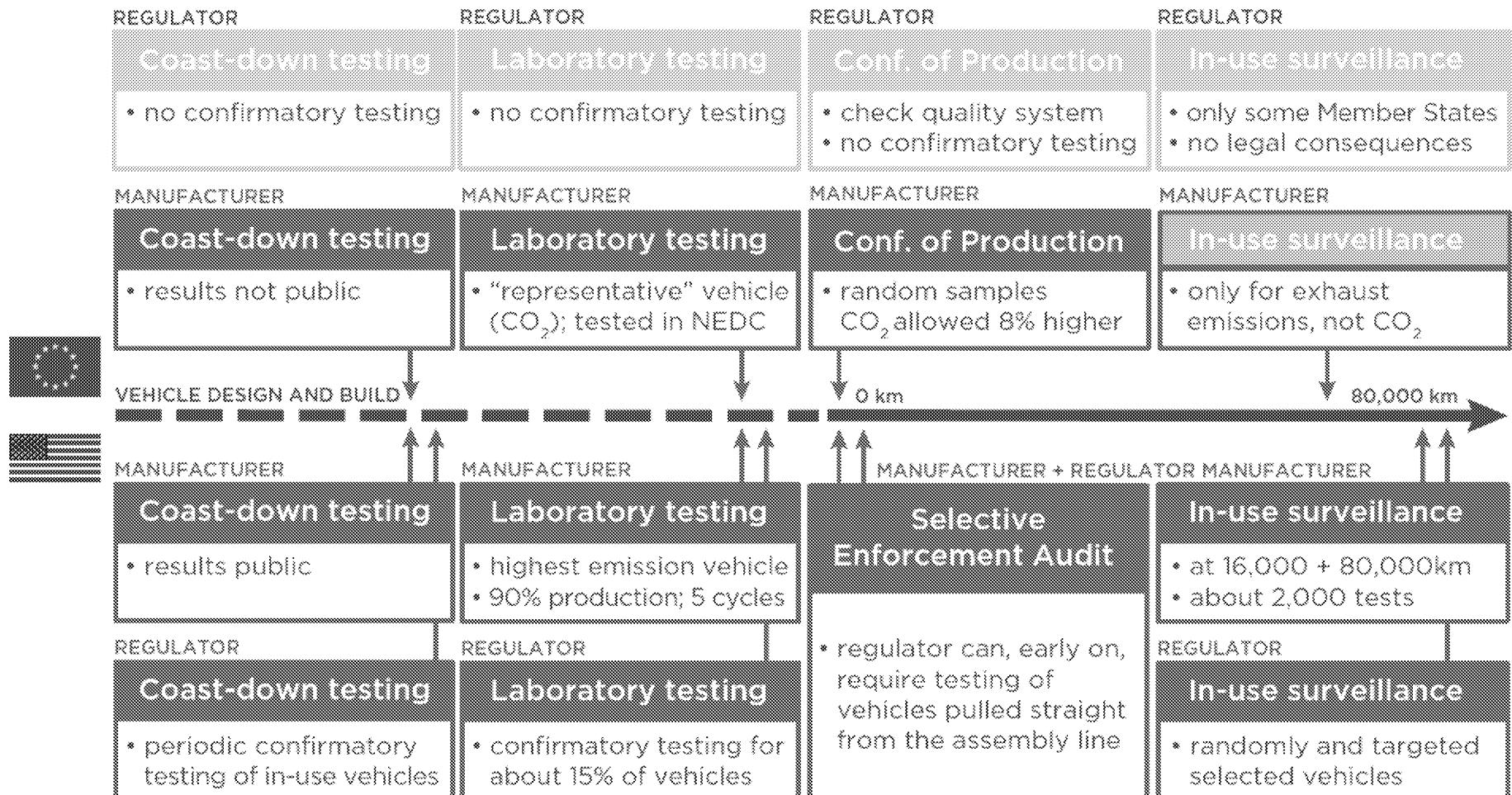


The introduction of the new WLTP test procedure could a) help or b) make things even worse!

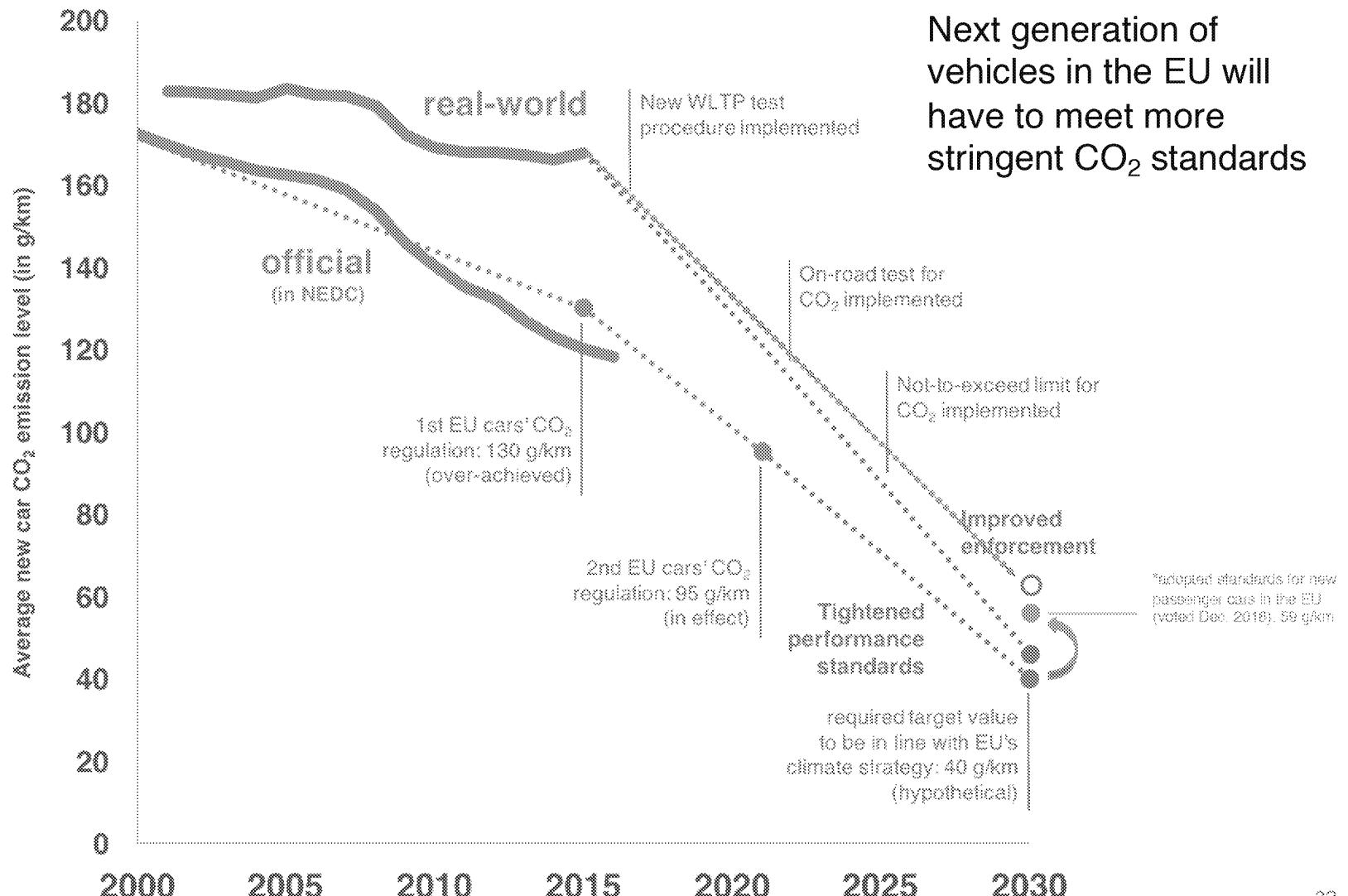




The best test procedure will remain toothless without independent re-testing and penalties



Monitoring of real-world CO₂ as well as a not-to-exceed limit for real-world CO₂ are required



Summary

EPA/CARB continue to improve an excellent program:

- Strong legal authority
- Extensive guidance and strong enforcement
- Test cycles cover wide range of operating and ambient conditions
- Unlimited ability to investigate defeat devices

EU has weak legal authority and enforcement, thus (appropriately) focusing on methods to improve:

- RDE will reduce range of defeat device operation
 - Remote sensing requirements would further improve
- WLTP will reduce CO₂ loopholes
 - Applying RDE to CO₂ would further improve

For more detail, please visit the ICCT website

The screenshot shows the homepage of the International Council on Clean Transportation (ICCT). At the top left is the 'icct' logo with the full name 'THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION' underneath. To the right is a search bar labeled 'search publications' and a magnifying glass icon. Next to it is a button labeled 'PUBLICATIONS' with a small gear icon. Below the header are four main navigation links: 'PROGRAMS', 'WHERE WE WORK', 'WHO WE ARE', and 'INFO & TOOLS'. To the right of these links is a graphic of several small circles of different sizes. The main content area features a large image of a car wheel and body, with the text 'The future of vehicle emissions testing and compliance' overlaid. Below this image is a navigation bar with numbers 1, 2, 3, and 4. To the right of the image is a world map with the heading 'WHERE WE WORK' and a 'SELECT REGION' dropdown. Below the map is a section titled 'TOPICS' with five listed items: 'Europe's vehicle CO2 targets', 'Airline fuel efficiency', 'US heavy-duty vehicle regulation', and 'In-use NOx emissions'.



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